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TARDEC Mobility Modeling & Simulation

CASSI/Analytics – Dynamics & Structures Team

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Part 1: What We Do

Life Cycle Modeling & Simulation Support

- Acquisition Support
  - Construct Virtual Technology Demonstrators
  - Develop automotive performance requirements
  - Write M&S content language of the Request For Proposal
  - Participate in the Source Selection Evaluation Board
- Field System Support
  - Configuration changes
  - Waiver requests
  - Safe Use Range of Operation

- **Examples of Mobility Events**
  - Vehicle stability
  - Ride quality
  - Durability
  - Maximum grade
  - Maximum side slope
  - Turning radius
  - Wall climbing
  - Gap crossing
  - Braking distance
  - Lane change
  - Dead engine steer
  - Steer characteristics
  - Maximum speed
  - Design loads
  - Design sensitivities
  - Water/Fuel transport

Multi-Body Vehicle Dynamics

Mobility Simulations Demo

Side Slope

TiltTable-Standard.wmv

Durability

ah32big.wmv

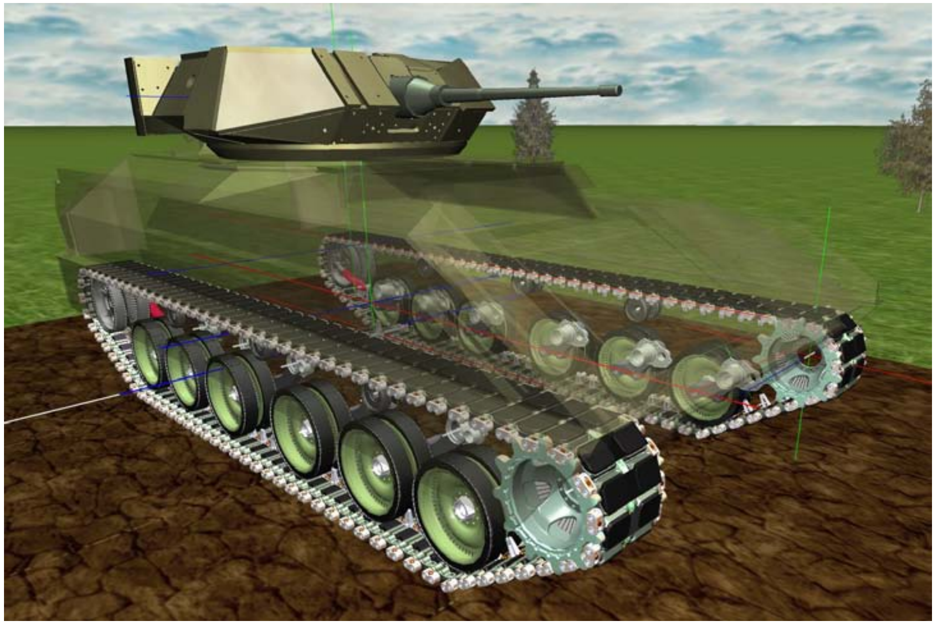
Lane Change

tan16700a-frontview.wmv

Braking

Brake-LSAC-40mph.wmv

Durability Simulation Demo



FE-Based Vehicle Dynamics

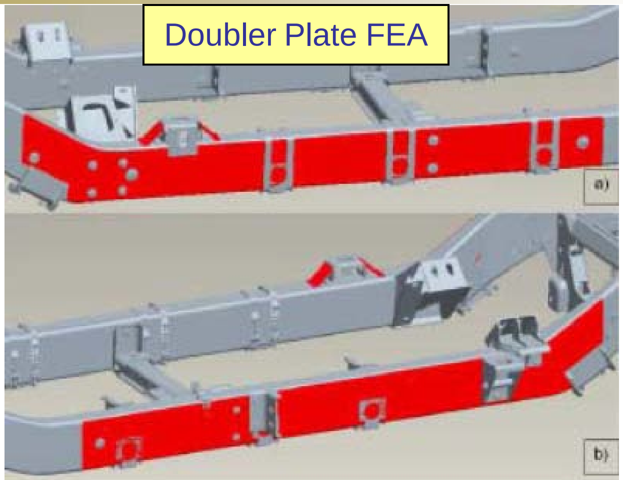
OPSEC_SegmentedTrack.avi

Fluid Transport Simulation Demo

Fluid-Structure Interaction

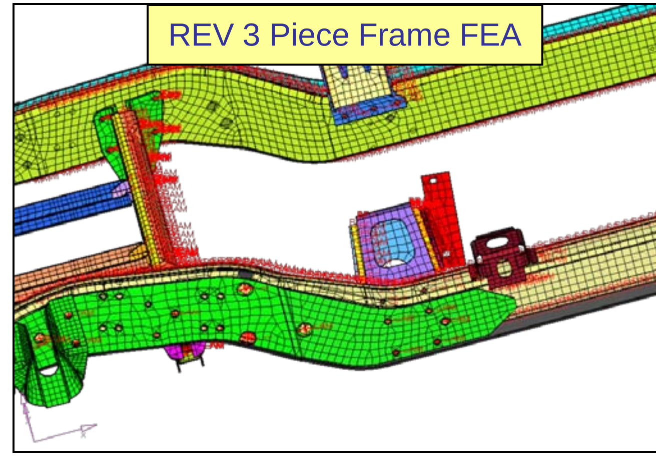
OPSEC_TankerTruck_LaneChange.avi

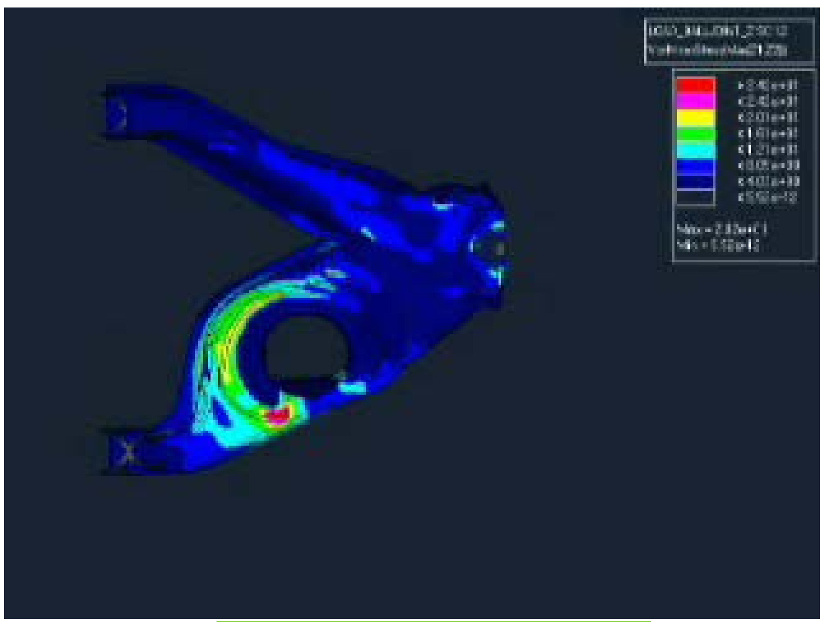
Doubler Plate FEA



Armor Effects on M1114 Frame Integrity

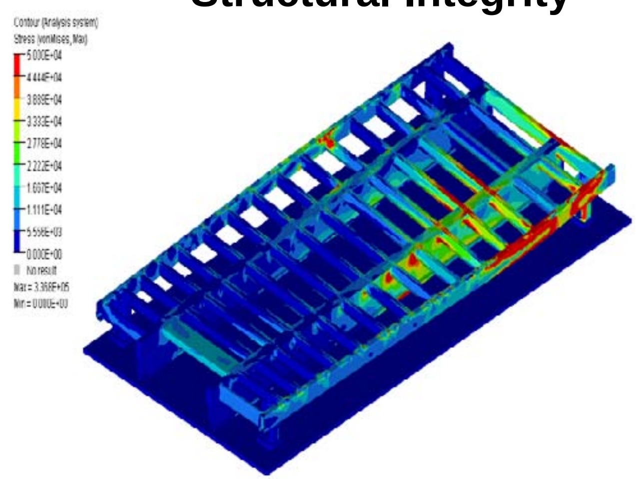
REV 3 Piece Frame FEA





M1114 Lower Control Arm

Structural Integrity



Finite Element Analysis

Platforms Supported

ASV

FTTS

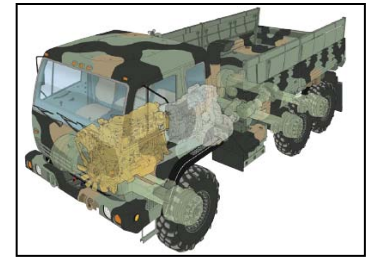
HMMWV

M2

MRAP

GCV

M915



FMTV

JLTV

Small Robot

APD

Part 2: Strategic Topics – Current & Future Needs

Strategic Topics: Modeling & Simulation

- Nonlinear flexible MBD
- Terramechanics
- Tracked vehicle modeling
- Tire modeling
- Terrain profiling
- Structure geometry modeling
- Active control systems
- Robotic vehicle modeling
- Nonlinear materials
- Contact, Impact, Friction, Discontinuity
- Probabilistic design

- Constraints, Recursive, Adaptive
- Stability, Robustness
- Multi-physics, Multi-scale
- MBD, FEM, Hybrid
- Implicit, Explicit, Adaptive, Hybrid
- Real-time efficiency
- Offline accuracy
- Parallel computation
- Software benchmark
- Verification & Validation

Strategic Topics: Example 1

- **Develop a Standard Vehicle Dynamic M&S Framework**
  - Build models, simulate events, assess performance, report results
  - Automatic design sensitivities, optimization, and confidence limits
  - Archive models, results, and reports
  - Common pre/post-processor independent of commercial software library
  - Benchmark new software by plug and play
  - Integrate CAD, FE, MBS
  - Adaptively choose generalized coordinates or recursive
  - Ability to run symbolic or numeric
  - Choice of serial or parallel computation
  - Selection of real-time or offline simulation
  - Built-in verification and validation
  - Perform MFO
  - Utilize industry standard tools
  - Emphasize new research
  - Endorsed by industry as a standard vehicle dynamic M&S framework

Strategic Topics: Example 2

- **Small Robot Mobility M&S**
  - How do we model small robots
  - What are the important model parameters
  - How to model terramechanics
  - Is the knowledge of large vehicle mobility scalable
  - How do we integrate sensors, controls, and actuators
  - What needs to be the requirements
  - What scenarios and events to simulate
  - How to simulate in real time accurately
  - What software is suitable for simulation
  - How do current M&S software perform
  - How to test hardware and correlate M&S results
  - How to improve robot reliability
  - What are academic/industry standards and references

Strategic Topics: Cross-Discipline Synergy

- **Cross pollinate with other disciplines**
  - Robotics
  - Biomechanics
  - Wind energy
  - Space research
  - Railway
  - Molecular dynamics

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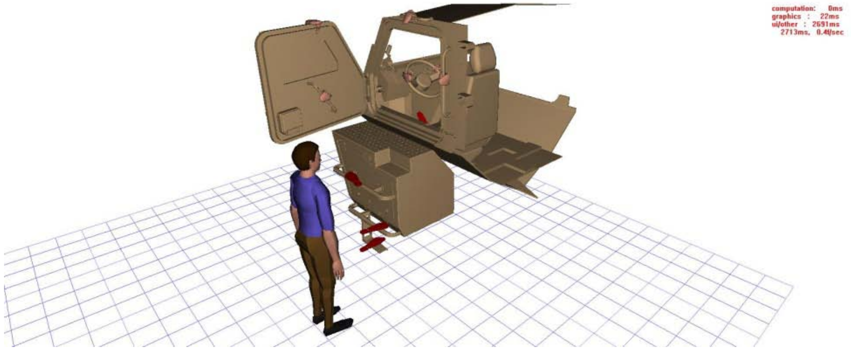
Human Centered Modeling and Simulation Needs

Human Centered Modeling and Simulation Needs

Overview: Researchers and Quad members of TA2 should develop modeling methodologies to;
•Improve seat comfort and reduce Soldier fatigue in tactical and combat vehicles.
•Improve ingress/egress modeling methods particularly in roll-over situations [egress].

No body armor

With body armor



Rationale: Seat Comfort. In the process of rapidly procuring Mine Resistant vehicles, some of them were designed with poor ride comfort due to stiff suspensions combined with uncomfortable seats. As a result, there have been many complaints from theater about the roughness of the ride and the comfort of the seats prompting the Army to take an active role in improved seat comfort.

Rationale: Ingress/Egress. Currently satisfying Soldier ingress/egress requirements require numerous human subjects trials involving real vehicles, mockups, and Soldiers. This consumes significant resources and time. Simulation methods can reduce the resource burden and permit more trade studies.